U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

NATIONAL WEATHER SERVICE CENTRAL REGION

KANSAS CITY, MISSOURI 64106

Regional Operations Manual Letter C-31-76

Date of Issue:	July 23, 1976	**Effective Date:**	July 23, 1976
In Reply Refer To:	WFC1x2	**File With:**	D-40

Subject: Livestock Hot Weather Stress

This supersedes ROML 71-13, dated May 5, 1971, same subject, filed with D-40, which should be destroyed.

A Weather Safety Index for livestock based on the NOAA National Weather Service's Temperature-Humidity (Comfort) Index (Attachment #5) was used by Livestock Conservation Inc. (19 West Chicago Avenue, Hinsdale, Illinois 60521) in a 13-year study of the livestock heat stress problem to arrive at critical index values. While the study was primarily for hogs, the relationship for cattle and other animals was found to be very similar.

WHAT THE INDEX MEANS

Most livestock do not adjust readily to high temperature (heat stress). Hogs are especially vulnerable when closely confined in a vehicle, building or pen. A careful study of the relationship of hog deaths during the marketing process shows that high temperatures, especially with high relative humidity, cause abnormally high losses.

When the outside temperature is above 80°, high death loss is quite closely related to the National Weather Service "Temperature-Humidity Index." Even though this index was originally developed to indicate comfort ranges for humans, Livestock Conservation Inc. studies and other research information point to similar ranges of comfort for animals. High values adversely influence efficiency of production, meat quality, health and survival.

THE FACTS ON HOGS

Heat builds up internally in the hog's body if it cannot be thrown off by the lungs or skin. If the internal temperature reaches 105-106°, heat exhaustion occurs and will be followed by death unless the situation is relieved.

Hogs lose about 80% of their body heat through the lungs when the environmental temperature is above 80°; only 20% is lost from the skin by radiation and air movement. Hogs must breathe approximately 20 times as much air at 100° as at 80° to maintain a safe internal body temperature (around 102° when their environmental temperature is 100°).

Hot, humid weather is more detrimental to livestock in the early summer than in mid- or late summer and during any season following an extended cool period. This heat tolerance has not been quantified but should be considered during periods of marginal danger or emergency categories.

The indices printed on the chart (Attachment #1) indicate the relative safety of livestock under various combinations of outside temperatures and percentage of relative humidity.

LIVESTOCK DANGER (Safety Index of 79-83)

An index in this category is dangerous for confined livestock, PARTICULARLY HOGS. There is also a need for precautionary measures in anticipation of a higher index. In fact, disaster can strike at the upper level of this range unless the proper safety steps are taken by stockmen.

LIVESTOCK EMERGENCY (Index of 84 and HIGHER)

Lack of cloud cover and little or no movement of air are additional hazards which can increase stress and should be considered. An emergency situation is most likely to develop when the temperature is 90 to 95 degrees early in the day, and higher temperatures are forecast for the period that the livestock will be in the marketing process. Additional stress created by handling livestock should be kept at an absolute minimum.

EFFECT OF WIND

The cooling effect of wind can lower the THI value a few degrees in open areas. However, when the air temperature approaches the skin temperature of the animal, the cooling effect of wind becomes minimal.

If a wind of 18 kts (20 MPH) or higher, is forecast for open areas during the period of concern and the air temperature is not expected to exceed 95 degrees, wind information will be included in Livestock Weather Safety Statements as indicated in the examples.

ISSUING OFFICES

All Central Region WSFO's are responsible for the issuance of non-routine "Livestock Weather Safety Statements." WSFO's within the bounded area, as mapped in Attachment #2, will issue "Danger" and/or "Emergency" Livestock Weather Safety Statements. These statements are to be issued whenever temperature/humidity conditions are forecast to be within the critical values established in either the "Danger" or "Emergency" category of Attachment #1. Those offices outside the bounded area will issue Livestock Weather Safety Statements only for the "Emergency" category. The "Alert" category in Attachment #1 will not be used by NWS offices.

Local offices should assure adequate dissemination of these statements during critical situations.

TIME OF ISSUANCE

Livestock Weather Safety Statements will be issued for all high temperature/relative humidity episodes (normally May 15 to September 15) regardless of the time of year. These statements should immediately follow the early morning state forecast, around 0600 CDT. If episodes are not anticipated in time for the early morning release, the release should be made as soon as the critical conditions are recognized. Each statement will cover a 24-hour period and an outlook the for next day.

Each Livestock Safety Statement will include a reference to that part of the day when critical index levels are expected; e.g., late this afternoon, this afternoon and early evening, etc.

CONTENT OF STATEMENT

1. Category expected in confined areas.
2. Critical period(s).
3. Wind, if greater than 20 MPH with a temperature less than 95°
   (if used, indicate less danger in open areas).
4. Outlook for next day.

NOTE: In the bounded area mapped in Attachment #2, whenever the Emergency category is expected, both terms "Danger and Emergency" categories will be used in the statements since it is not practical to state expected category changes in detail; i.e., Danger to Emergency to Danger.

CANCELLATION STATEMENT

A final cancellation statement should be issued at the conclusion of an episode using the same heading in the examples below. The text should state the reason for the weather change; e.g., an influx of drier or cooler air will alleviate the critical livestock weather safety conditions.

EXAMPLES

Sample statements with standard heading are shown below for guidance:

LIVESTOCK WEATHER SAFETY STATEMENT
NATIONAL WEATHER SERVICE
ST. LOUIS, MISSOURI
610 AM CDT MONDAY JUNE 14, 1976

WARM HUMID CONDITIONS WILL CAUSE THE LIVESTOCK SAFETY INDEX TO REACH THE DANGER CATEGORY OVER MOST OF MISSOURI FOR LIVESTOCK IN CONFINED AREAS BEGINNING LATE THIS FORNOON AND CONTINUING UNTIL EARLY EVENING.

SOUTHERLY WINDS 20-30 MPH THIS AFTERNOON WILL REDUCE THE DANGER IN OPEN AREAS. THE HIGH TODAY IS FORECAST TO BE 90-95 WITH A RELATIVE HUMIDITY OF 50 PERCENT.

SIMILAR CONDITIONS CAN BE EXPECTED AGAIN TUESDAY AFTERNOON AND EVENING.

*** *** ***

LIVESTOCK WEATHER SAFETY STATEMENT
NATIONAL WEATHER SERVICE
OMAHA, NEBRASKA
1015 AM CDT TUESDAY JUNE 29, 1976

HIGH TEMPERATURES AND HUMID CONDITIONS OVER THE EASTERN THIRD OF NEBRASKA HAVE RESULTED IN A LIVESTOCK SAFETY INDEX IN THE DANGER CATEGORY AS OF 10 AM THIS FORENOON. THE INDEX IS EXPECTED TO REMAIN IN THE DANGER TO EMERGENCY CATEGORIES THIS AFTERNOON AND THROUGH THE EARLY EVENING HOURS.

THE HIGH TODAY IS FORECAST TO BE 95 TO 100 WITH A RELATIVE HUMIDITY OF 40 PERCENT.

THE FORECAST FOR WEDNESDAY INDICATES A CONTINUATION OF HOT HUMID CONDITIONS.

*** *** ***

LIVESTOCK WEATHER SAFETY STATEMENT
NATIONAL WEATHER SERVICE
OMAHA, NEBRASKA
550 AM CDT MONDAY JULY 12, 1976

HOT AND RATHER HUMID CONDITIONS ARE FORECAST TODAY OVER EASTERN NEBRASKA AND PARTICULARLY IN THE MISSOURI VALLEY. CONDITIONS WILL RESULT IN A LIVESTOCK SAFETY INDEX IN THE DANGER TO EMERGENCY CATEGORIES FROM ABOUT 10 AM TODAY THROUGH THE EARLY EVENING HOURS.

HIGH TEMPERATURES TODAY WILL BE 95-100 WITH A RELATIVE HUMIDITY OF 40 PERCENT.

SIMILAR CONDITIONS ARE EXPECTED AGAIN ON TUESDAY JULY 13, 1976.

*** *** ***

LIVESTOCK WEATHER SAFETY STATEMENT
NATIONAL WEATHER SERVICE
DES MOINES, IOWA
6:00 AM CDT WEDNESDAY AUGUST 4, 1976

THE TEMPERATURE TODAY SHOULD REACH THE LOW 90'S. THIS TEMPERATURE COMBINED WITH A RELATIVE HUMIDITY OF NEAR 40 PERCENT WILL RESULT IN A LIVESTOCK SAFETY INDEX IN THE DANGER CATEGORY FOR LIVESTOCK IN CONFINED AREAS DURING THE AFTERNOON HOURS.

SOUTHERLY WINDS 20 TO 25 MPH WILL LESSEN THE DANGER IN OPEN AREAS.

NORTHERLY WINDS ACCOMPANIED BY COOLER AND DRIER AIR IS EXPECTED TO SPREAD OVER IOWA TONIGHT WHICH WILL ELIMINATE CRITICAL LIVESTOCK HEAT STRESS FOR THE NEXT SEVERAL DAYS IN IOWA.

*** *** ***

In the interest of general information, the following paragraph should be appended to the initial issuance of a Livestock Weather Safety Index Statement during each high temperature/humidity episode:

RESEARCH HAS SHOWN THAT A FIGURE WHICH COMBINES BOTH TEMPERATURE AND RELATIVE HUMIDITY CAN PROVIDE A MEASURE OF HEAT STRESS TO LIVESTOCK, PARTICULARLY ANIMALS THAT ARE CONFINED OR BEING LOADED OR TRANSPORTED. THIS COMBINATION FIGURE IS CALLED THE LIVESTOCK WEATHER SAFETY INDEX.

On Thursday, July 3, 1969, and again July 12-15, 1969, there was a heavy loss of poultry and livestock in an area along the Missouri River Valley from Sioux City, Iowa, to Kansas City (See Attachment #4). Forecasters may want to become familiar with these synoptic situations.

Attachment #3 includes notes on the Temperature/Humidity Index (THI) as used by the National Weather Service in some areas as a "Comfort Index" for humans computed from the dry bulb temperature and the relative humidity.

Charles G. Knudsen

Charles G. Knudsen
Director, Central Region

Attachments

cc: W113

LIVESTOCK WEATHER SAFETY INDEX

Adapted from "Notes on Temperature-Humidity Index", NOAA NATIONAL WEATHER SERVICE

ATTACHMENT #1

DRY BULB TEMP.	RELATIVE HUMIDITY INTERVALS (%)																			
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
75									70	70	71	71	72	72	73	73	74	74	75	75
76							70	70	70	71	72	72	72	73	74	74	74	75	76	76
77						70	70	71	71	72	72	73	73	74	74	75	75	76	76	77
78					70	70	71	71	72	72	73	74	74	75	75	[illegible]	[illegible]	77	78	78
79				70	70	71	72	72	73	73	74	74	[illegible]	[illegible]	[illegible]	[illegible]	77	78	78	[illegible]
80			70	70	71	72	72	73	73	74	74	75	[illegible]	[illegible]	[illegible]	78	78	79	79	[illegible]
81		70	70	71	71	72	73	73	74	75	75	76	[illegible]	[illegible]	78	78	79	80	80	[illegible]
82		70	71	71	72	73	73	74	75	75	76	[illegible]	[illegible]	78	79	[illegible]	[illegible]	[illegible]	81	[illegible]
83	70	71	71	72	73	73	74	75	75	76	7[illegible]	[illegible]	78	79	[illegible]	[illegible]	81	[illegible]	[illegible]	[illegible]
84	70	71	72	72	73	74	75	75	76	77	78	78	79	80	80	81	82	[illegible]	[illegible]	84
85	71	72	72	73	74	75	75	76	77	78	78	79	80	81	81	[illegible]	[illegible]	84	84	85
86	71	72	73	74	74	75	76	77	78	78	79	[illegible]	[illegible]	[illegible]	82	[illegible]	84	84	85	[illegible]
87	72	73	73	74	75	76	77	77	78	79	80	81	[illegible]	[illegible]	[illegible]	84	85	[illegible]	[illegible]	[illegible]
88	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	[illegible]	[illegible]	87	[illegible]	[illegible]
89	73	74	74	75	76	77	78	79	80	80	81	82	[illegible]	84	85	86	86	87	[illegible]	[illegible]
90	73	74	75	76	77	78	79	79	80	[illegible]	[illegible]	[illegible]	84	85	86	87	87	[illegible]	[illegible]	[illegible]
91	74	75	76	76	77	78	79	80	81	[illegible]	[illegible]	84	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
92	74	75	76	77	78	79	80	81	82	[illegible]	84	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
93	75	76	77	78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
94	75	76	77	78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
95	76	77	78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
96	76	77	78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
97	77	78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
98	77	78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
99	78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100	78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
105	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Alert

NOT APPLICABLE TO NWS STATEMENTS

Danger

Emergency

DANGER - EXPECT 25% or more increase in transit loss!

EMERGENCY - Expect 45% or more increase in transit loss!!

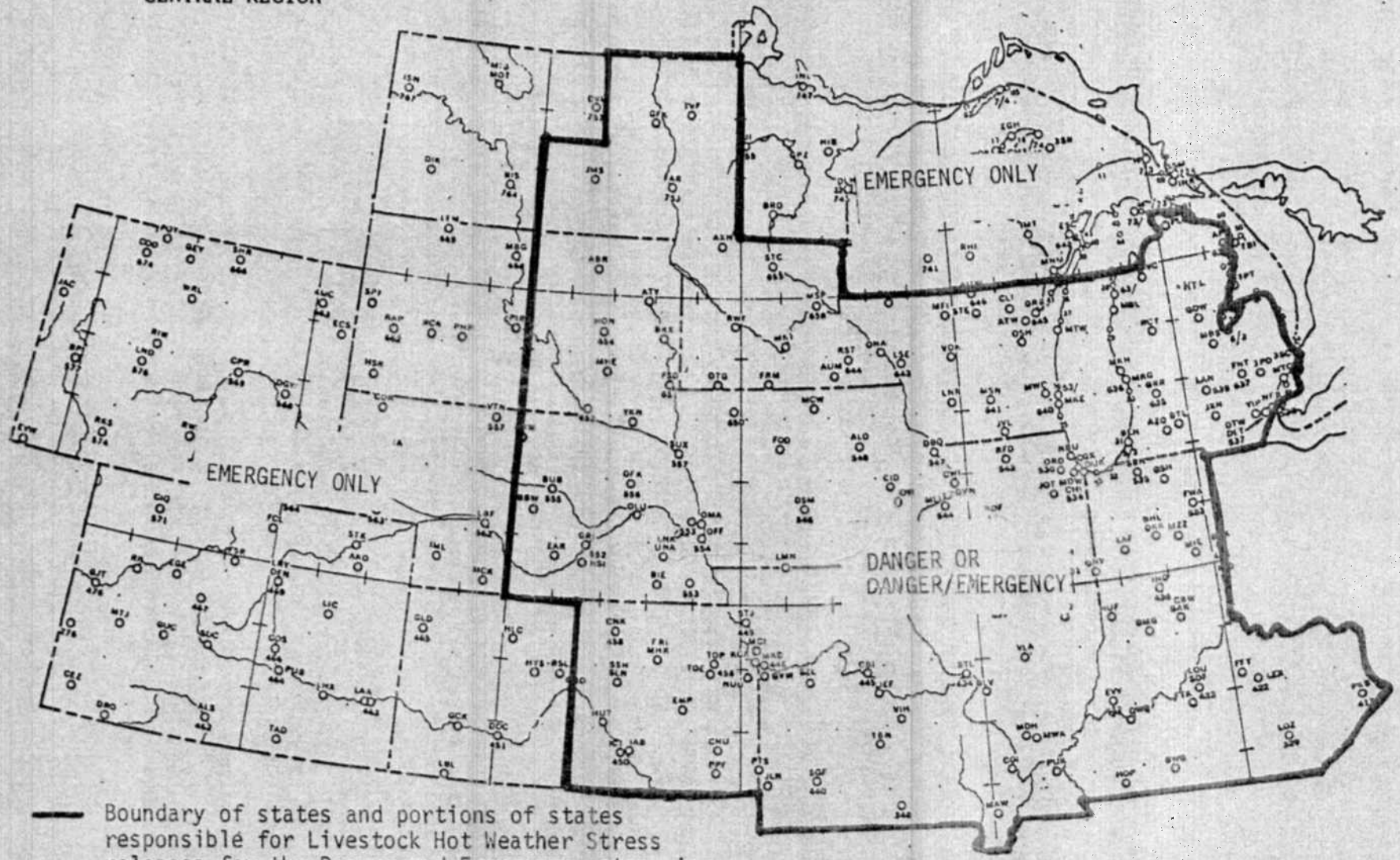
Livestock Conservation, Inc.

NATIONAL OFFICE
19 West Chicago Avenue
Hinsdale, Illinois 60521

ATTACHMENT #2

LIVESTOCK HOT WEATHER STRESS

NOAA NATIONAL WEATHER SERVICE
CENTRAL REGION



Boundary of states and portions of states responsible for Livestock Hot Weather Stress releases for the Danger and Emergency categories.

ATTACHMENT #3

NOTES ON TEMPERATURE-HUMIDITY INDEX

Various combinations of heat and moisture in the air cause diverse sensations of comfort or discomfort in human beings. A single index can be used to express this combined temperature-humidity effect on most people, although it is also known that individual reactions vary considerably from person to person.

"Temperature-Humidity Index" (T.H.I.) is a term used by the National Weather Service to indicate the combinations of temperature and air moisture; i.e., the "Effective Temperature."

As early as 1923 the American Society of Heating and Ventilating Engineers started a research project which resulted in the introduction of the term "effective temperature." By extensive laboratory tests "effective temperature values" were established for each group of separate simultaneous dry bulb temperature and relative humidity readings which gave equivalent feelings of comfort.

The "Temperature-Humidity Index" has potential value and usefulness because of its direct relationship with the level of comfort experienced by most human beings. Relatively few people in summer will be uncomfortable from heat and humidity while the Temperature-Humidity Index is 70 or below. About half of the people will be uncomfortable by the time the Temperature-Humidity Index reaches 75. Almost everyone will be uncomfortable by the time the Temperature-Humidity Index reaches 79, and discomfort becomes more acute as the index climbs still higher. Infrequently, in some parts of the United States the Temperature-Humidity Index values reach as high as 90.

Any of the following equations may be used to determine T.H.I. values. The choice of the equation used depends upon the available data.

(1) T.H.I. = 0.4 (td + tw) + 15
(2) T.H.I. = .55 td + .2 tdp + 17.5
(3) T.H.I. = td - (0.55 - 0.55 RH) (td - 58) (See Attachment #1)

Where T.H.I. is Temperature-Humidity Index; td is dry bulb temperature in °F; tw is wet bulb temperature in °F; tdp is dew point temperature in °F; RH is relative humidity expressed in decimals (e.g., 0.65 is used for 65%).

ATTACHMENT #4

PROFILE OF "HAZARDOUS WEATHER" FOR LIVESTOCK

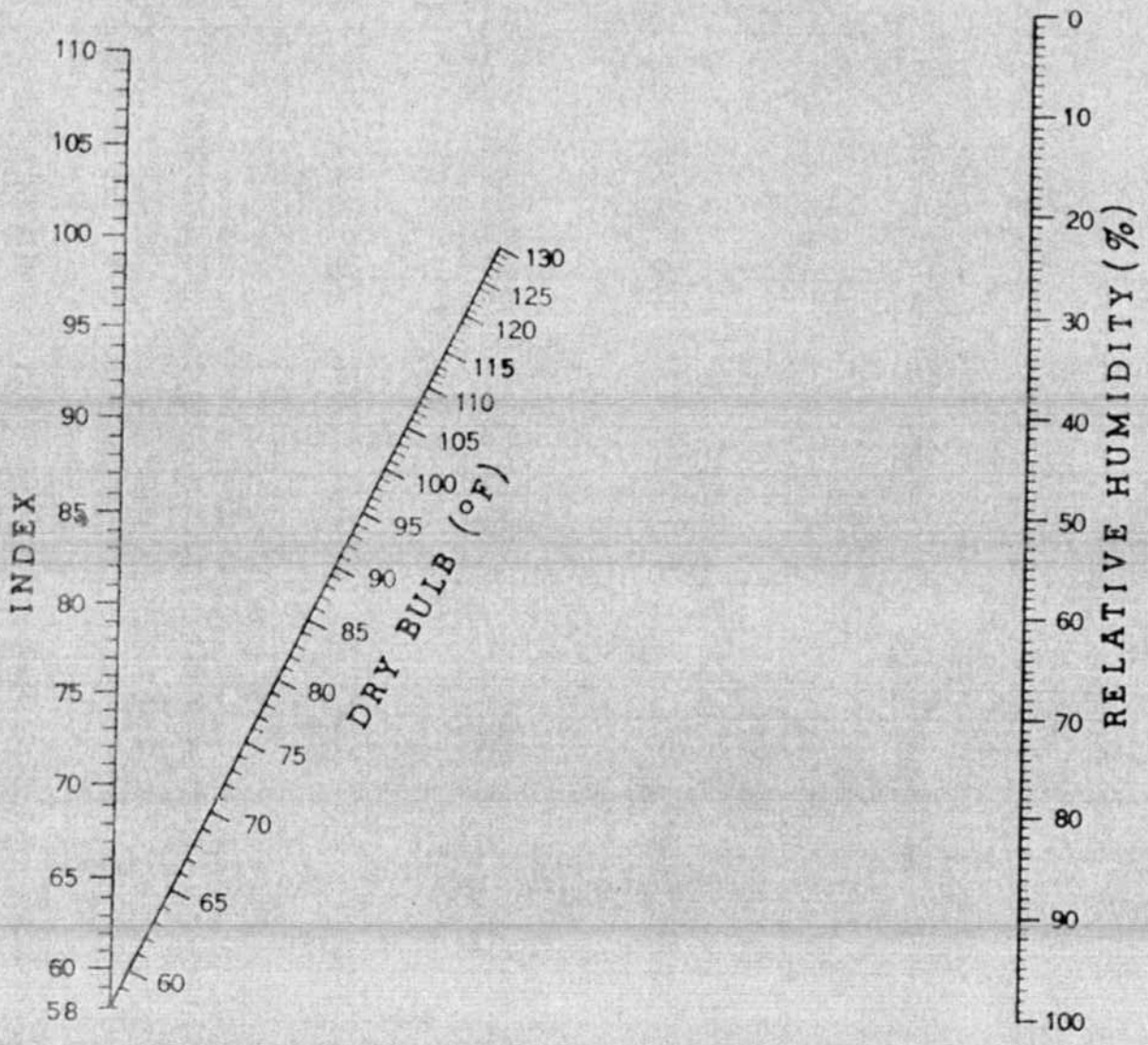
Period of High Cattle Losses in Midwest, July 12-15, 1969

LCI Weather Safety Index, Based on Selected Weather Offices

Hour	Sioux Falls	Sioux City	Omaha	Kansas City	St. Louis	Moline	Waterloo	Madison
				Friday, July 11, 1969				
Midnight	68	70	69	77	75	73	75	67
3 a.m.	68	68	68	76	75	71	68	67
6 a.m.	68	67	68	76	75	72	68	68
9 a.m.	72	72	74	79	76	79	74	76
12 Noon	76	77	79	81	81	81	77	77
3 p.m.	79	81	82	83	82	82	78	78
6 p.m.	79	82	83	82	82	79	77	76
9 p.m.	75	79	78	79	78	75	73	71
				Saturday, July 12, 1969				
Midnight	70	76	77	77	77	72	71	67
3 a.m.	65	75	75	77	75	70	68	66
6 a.m.	67	75	76	77	75	71	69	70
9 a.m.	77	80	82	80	82	79	78	77
12 Noon	81	84	85	84	83	82	80	80
3 p.m.	82	87	87	85	83	82	81	81
6 p.m.	82	87	86	85	83	81	80	71
9 p.m.	79	81	81	81	80	77	74	71
				Sunday, July 13, 1969				
Midnight	78	80	81	79	79	74	71	67
3 a.m.	77	78	77	76	78	72	69	63
6 a.m.	76	77	77	77	77	72	71	66
9 a.m.	79	82	82	82	83	78	79	73
12 Noon	84	85	85	85	85	80	74	77
3 p.m.	85	87	87	86	86	81	80	78
6 p.m.	85	87	85	85	83	79	77	76
9 p.m.	81	83	81	82	79	74	76	72
				Monday, July 14, 1969				
Midnight	76	80	79	79	75	71	75	69
3 a.m.	73	77	77	78	74	71	71	66
6 a.m.	71	76	77	77	74	71	71	65
9 a.m.	79	82	80	79	79	77	75	73
12 Noon	82	84	84	84	81	79	75	76
3 p.m.	83	87	87	85	81	81	75	77
6 p.m.	81	86	86	84	79	79	78	75
9 p.m.	79	81	80	83	74	73	75	71
				Tuesday, July 15, 1969				
Midnight	79	80	79	81	71	71	73	71
3 a.m.	73	79	79	83	71	68	69	70
6 a.m.	73	77	78	77	71	69	71	70
9 a.m.	78	80	80	79	77	75	74	73
12 Noon	81	85	84	83	79	77	79	76
3 p.m.	83	86	86	85	81	79	81	76
6 p.m.	82	86	86	84	79	77	79	75
9 p.m.	77	81	83	82	73	74	77	73

ATTACHMENT #5

STRAIGHT LINE NOMOGRAM FOR DETERMINING TEMPERATURE HUMIDITY INDEX FROM THE DRY BULB TEMPERATURE AND THE RELATIVE HUMIDITY



At temperatures 58° and below use the index numerically equal to the dry bulb temperature

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC & ATMOSPHERIC ADMIN.
NATIONAL WEATHER SERVICE

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